INSURING THE PROPER RETURN OF QUERIES REQUESTED BY WORLD WIDE WEB CLIENT STATIONS FROM WEB SOURCES WHEN DYNAMIC IP ADDRESSES ARE ASSIGNED TO CLIENT STATIONS

Technical Field

5   The present invention relates to computer managed communication networks such as the World Wide Web (Web) and, particularly, to handling of Web client station query requests when using conventional TCP/IP (Transmission Control Protocol/Internet Protocol)
10   protocols wherein dynamic IP addresses are temporarily assigned to the client station for each request transaction.

Background of Related Art

The past decade has been marked by a technological
15   revolution driven by the convergence of the data processing industry with the consumer electronics industry. The effect has, in turn, driven technologies which have been known and available but relatively quiescent over the years. A major one of these
20   technologies is the Internet or Web related distribution of documents, media and files. The convergence of the electronic entertainment and consumer industries with data processing exponentially accelerated the demand for wide ranging communication distribution channels, and the
25   Web or Internet, which had quietly existed for over a generation as a loose academic and government data distribution facility, reached "critical mass" and commenced a period of phenomenal expansion. With this expansion, businesses and consumers have direct access to
30   all matter of documents and computer files. This rapid expansion has brought hundreds of millions of Web users

at hundreds of millions of Web stations, i.e. client
computer stations on the Web. In addition, Hypertext
Markup Language (HTML), which had been the documentation
language of the Internet or Web for years, offered direct
5   links between Web pages. This even further exploded the
use of the Internet or Web.

Web documents are provided from a Web distribution
site or resource location usually made up of one or more
network server computers which access the document
10   (query) from a resource database in response to a user
query request sent over the Web, usually through a Web
browser on the user's receiving client computer station.
Web distribution sites or resource locations usually
serve large institutions such as corporations,
15   universities, retail stores or governmental agencies.
These distribution sites may also provide to smaller
businesses or organizations support for and distribution
of individual Web pages created, owned and hosted by the
individual small businesses and organizations. The
20   network server computers that control the document and
file distribution over the Web or Internet (terms are
used interchangeably), include, in addition to servers
which are at the resource locations, the servers of the
Web Service Providers, e.g. cashing servers, through
25   which the receiving client computer stations are
connected into the Web, the Web servers which provide the
client or user requested contents (query results) and
through which the receiving client computer stations are
connected into the Web, as well as resource servers at
30   the other end that in turn connect the resource databases
into the Web.

Conventional Web transactions use TCP/IP to move
data or manage Web traffic. Data or content is moved in
packets, each of which contains, in addition to its
content, enough data to route the packet through to its
5   destination. Web routers interpret the route data and
move the packet to its destination address. The address
is the numerical IP address. Each destination, e.g. Web
client station must have such an IP address, either
temporary or permanent in order for any Web transaction
10   to be completed. Since such numerical addresses would be
difficult to remember and are often temporary, each Web
station has a unique domain name. There is a Domain Name
System (DNS) for translating such numerical IP addresses
into the Web site's domain name. Most of the access to
15   the Web or Internet by the hundreds of millions of client
users is through Internet or Web Service Providers that
provide wired or wireless, usually dial-in, access to
Provider servers that handle and transmit client query
requests using TCP/IP protocols. Such service providers
20   assign each client a new temporary IP address each time
the client calls in, i.e. for each query request. This
enables the service provider to get along with fewer IP
addresses because the provider only needs enough IP
addresses for the maximum number of clients who may be
25   simultaneously dialed-in, i.e. actively requesting
queries. This TCP/IP protocol is known as DHCP (Dynamic
Host Configuration Protocol).

While protocols, such as DHCP, that assign temporary
IP addresses have been very effective in minimizing the
30   number of addresses which the service provider needs to
inventory, the protocol has given rise to problems.
Because of the very high volume of Web transactions that
any given service provider must handle, IP addresses may

be very rapidly reassigned after any interruption of contact with the requesting client. In most situations, an interruption or cut off by the requesting client, or the expiration of allotted time, e.g. lease time

5   indicates that he has received his query response and the transaction is over. In such a case, the IP address may be reassigned without any problems.

However, problems may arise when the connection or contact with the client is cut off before the Web server

10   to which the service provider has routed the query request has received the requested data and the query response has been returned to the IP address assigned to the client. If immediately after the initial client cut off the assigned IP address has been reassigned to

15   another client, the Web server will then return the query response to the initial address which has now been reassigned to the new other client. This will be very confusing to the new client because the query response will have nothing to do with any query response that he

20   may be expecting. In fact, in the present Internet climate with great exposure to malicious hacking, as well as various protective firewall protocols to protect against such hacking, the random or stray arrival of unrequested data may give rise to the suspicion of a

25   malicious intrusion and trigger all manner of disruptions.

Unfortunately, unintended cut offs by clients that could lead to the above-described problem may be expected to be on the increase. With more and more inexperienced

30   people trying to use the Web, there will be increased instances of the unsophisticated client switching on and off repeatedly to the service provider before waiting for responses to queries to play out and be returned. Also,

with the great increase in pervasive, e.g. wireless "on-the-run", access to the Web via Personal Digital Assistants (PDAs), palm computers and cellular phones, we can expect greater unintended cut offs since these

5   devices are notoriously prone to such disruptions in service.

One solution has been to delay the reassignment of IP addresses for periods sufficient to eliminate the late arrival of query responses to reassigned IP addresses.

10   However, with the current increase in Web usage, even simple delays in reassignment could result in an exponential increase in the number of IP addresses that a high activity service provider would have to inventory.

Summary of the Present Invention

15   The present invention provides a solution to the problem of routing inappropriate earlier query responses to IP addresses which have already been reassigned. It does so without any increase in the number of IP addresses that a service provider would have to inventory

20   for distribution under DHCP protocols. The invention provides an Internet system for the handling of query requests from a client station comprising a service provider supporting a set of said plurality of client stations. The provider has server means responsive to

25   each query request from each of said set of client stations for assigning one of a set of IP addresses to each requesting client station and means for sending each query request to a Web server. The Web server includes means for determining if said assigned IP address is

30   still assigned to said requesting client station in combination with means for sending a query response to

said requesting client station only if said IP address is
still assigned to said requesting station.

The service server operates conventionally so that
the means for assigning said IP addresses assigns an IP
5 address to one requesting client station for only as long
as the one requesting client station continues the query
request, i.e. there must be a discontinuance or
disruption before dynamic reassignment can take place.

The requesting client station may be a wireless
10 mobile station in which case there will be Web means for
receiving a wireless query request from the mobile
station within a limited range of transmission distance;
but the mobile station is enabled to move out of said
limited range to thereby discontinue said query request
15 to give rise to the unintended disruption of service
initiated IP address reassignment problems which the
present invention solves.

In the preferred implementation of the invention,
the service provider means further includes database
20 means for recording the IP addresses dynamically assigned
to client stations and the means in said Web server for
determining if said assigned address is still assigned
access to said database to make such a determination.

Thus, with the present invention, there are no
25 circumstances wherein a query response to an interrupted
query request from an earlier client station can be sent
to an IP address reassigned to a subsequent client
station. Quite simply stated, if the IP address made
available for reassignment by the interruption of the
30 original assigned client has not been reassigned, then a
late query response will be attempted to the initially
assigned address. Then, if the original client has re-
established contact, it will receive the query response.

If the original client has not established contact, there
will be no active client at the address and the response
will either be stored for the client or it will be
discarded dependent upon the set up. On the other hand,
5   if the IP address has been reassigned, no response will
be made and, consequently, no confusion.

Brief Description of the Drawings

The present invention will be better understood and
its numerous objects and advantages will become more
10   apparent to those skilled in the art by reference to the
following drawings, in conjunction with the accompanying
specification, in which:

Fig. 1 is a block diagram of a data processing
system including a central processing unit and network
15   connections via a communications adapter which is capable
of implementing the client stations, as well as the
servers used by the service provider and Web servers in
accordance with the present invention;

Fig. 2 is a generalized diagrammatic view of a World
20   Wide Web portion upon which the present invention is
implemented;

Fig. 3 is an illustrative flowchart describing the
setting up of the elements needed for the program of the
present invention for the dynamic reassignment of IP
25   addresses without errant transmission of query responses
to reassigned IP addresses resulting from unintended
disruption of connections to clients to which IP
addresses were originally assigned; and

Fig. 4 is a flowchart of an illustrative run of the
30   program set up in Fig. 3.

Detailed Description of the Preferred Embodiment

Referring to Fig. 1, a typical general data
processing system is shown which may function as the
client computer station, a server for the service

5   provider or a Web server, the operation of which will be
described in greater detail with respect to Fig. 2.

A Central Processing Unit (CPU) 10, such as one of
the PC microprocessors or workstations, e.g. RISC
System/6000$^{(TM)}$ (RS/6000) series available from

10   International Business Machines Corporation (IBM), is
provided and interconnected to various other components
by system bus 12. An operating system 41 runs on CPU 10,
provides control and is used to coordinate the function
of the various components of Fig. 1. Operating system 41

15   may be one of the commercially available operating
systems such as the AIX 6000$^{(TM)}$ operating system available
from IBM; Microsoft's Windows98$^{(TM)}$ or WindowsNT$^{(TM)}$, as
well as the UNIX and AIX operating systems. Application
programs 40, controlled by the system, are moved into and

20   out of the main memory Random Access Memory (RAM) 14.
These programs include the programs used in the present
invention for sending query requests, which are
distributed through the service provider to various Web
servers and for receiving query responses from these

25   servers. These functions will be subsequently described
in greater detail in combination with any conventional
Web browser, such as the Netscape Navigator 3.0$^{(TM)}$ or
Microsoft's Internet Explorer$^{(TM)}$. A Read Only Memory
(ROM) 16 is connected to CPU 10 via bus 12 and includes

30   the Basic Input/Output System (BIOS) that controls the
basic computer functions. RAM 14, I/O adapter 18 and
communications adapter 34 are also interconnected to
system bus 12. I/O adapter 18 may be a Small Computer

System Interface (SCSI) adapter that communicates with the disk storage device 20. Communications adapter 34 interconnects bus 12 with an outside network enabling the data processing system to communicate with other such

5   systems over a Local Area Network (LAN) or a Wide Area Network (WAN), which includes, of course, the Web or Internet. I/O devices are also connected to system bus 12 via user interface adapter 22 and display adapter 36. Keyboard 24 and mouse 26 are all interconnected to bus 12

10 through user interface adapter 22. It is through such input devices that the user may interactively relate to Web documents, pages or files. Display adapter 36 includes a frame buffer 39, which is a storage device that holds a representation of each pixel on the display

15 screen 38. Images may be stored in frame buffer 39 for display on monitor 38 through various components, such as a digital to analog converter (not shown) and the like. By using the aforementioned I/O devices, a user is capable of inputting information to the system through

20 the keyboard 24 or mouse 26 and receiving output information from the system via display 38.

　　　Before going further into the details of specific embodiments, it will be helpful to understand from a more general perspective the various elements and methods

25 which may be related to the present invention. Since an aspect of the present invention is directed to Web query responses transmitting Web resource content that would include documents, pages or files transmitted over the Web or Internet, an understanding of networks and their

30 operating principles would be helpful. We will not go into great detail in describing the networks to which the present invention is applicable. For details on Web nodes, objects and links, reference is made to the text,

Mastering the Internet, G. H. Cady et al., published by
Sybex Inc., Alameda, CA, 1996; or the text, Internet:
The Complete Reference, Millennium Edition, Margaret
Young et al., Osborne/McGraw-Hill, Berkeley, CA, 1999.

5   Any data communication system that interconnects or
links computer controlled systems with various sites
defines a communications network. Of course, the
Internet or Web is a global network of a heterogeneous
mix of computer technologies and operating systems.

10 Higher level objects are linked to the lower level
objects in the hierarchy through a variety of network
server computers. These network servers are the key to
network distribution, such as the distribution of Web
pages and related documentation. Web documents are

15 conventionally implemented in HTML language, which is
described in detail in the text entitled Just Java, van
der Linden, 1997, SunSoft Press, particularly at Chapter
7, pp. 249-268, dealing with the handling of Web pages;
and also in the above-referenced Mastering the Internet,

20 particularly pp. 637-642, on HTML in the formation of Web
pages. In addition, aspects of this invention will
involve Web browsers. A general and comprehensive
description of browsers may be found in the above-
mentioned Mastering the Internet text at pp. 291-313.

25 More detailed browser descriptions may be found in the
above-mentioned Internet: The Complete Reference,
Millennium Edition, Chapter 19, pp. 419-454, on the
Netscape Navigator; Chapter 20, pp. 455-494, on the
Microsoft Internet Explorer; and Chapter 21, pp. 495-512,

30 covering Lynx, Opera and other browsers.
     A generalized diagram of a portion of the Web in
which the computer controlled client display station 57
is used for receiving Web pages or documents using a Web

browser 59 is connected as shown in Fig. 2. Client
computer display station 57 with display 56 may be
implemented by the computer system setup in Fig. 1 and
connection 58 (Fig. 2) is the network connection shown in
5 Fig. 1. Reference may be made to the above-mentioned
Mastering the Internet, pp. 136-147, for typical
connections between local display stations to the Web via
network servers, any of which may be used to implement
the system on which this invention is used. The system
10 embodiment of Fig. 2 has a host-dial connection. Such
host-dial connections have been in use for over 30 years.
The connections are made through a service provider
server 64 through Web servers 63 that are linked 61 to
the Web 50. The Service Provider server 64 is accessed
15 by the client station 57 through a normal dial-up
telephone linkage 58 via modem 54, telephone line 55 and
modem 52. The client station 57 makes its requests for
data from the Web as query requests made to the Web
access server 63 through the Service Provider server 64.
20 Server 64 uses DHCP protocols that assigns each client a
new temporary IP address each time the client calls in,
i.e. for each query request. This enables the service
provider to get along with fewer IP addresses because the
provider only needs enough IP addresses for the maximum
25 number of clients who may be simultaneously dialed-in,
i.e. actively requesting queries.

The connection to Provider server 64 may also be
made through wireless modems, described, for example, at
pages 148 and 149 of the text, Palm III & Palm Pilot,
30 Jeff Carlson, Peachpit Press, 1998. In present
technology, wireless client stations thus connected to
the Web are often mobile and, thus, pervasive. These
terminals, also known as PDAs. include for example,

Motorola's Two-Way Pager/PDA, the 3Com PalmPilot^(TM) and
IBM's WorkPad^(TM). Current estimates are that there are
more than fifteen million of these devices in present
usage.

5   Query responses that are likely to include Web
documents are accessed through Web server 63 via the Web
50 and Web data resources 60 and 62, and returned or
downloaded back to client station 57 via the same
telephone line linkages from server 63. As mentioned

10   above, the present invention protects against a premature
reassignment of an IP address by Service Provider server
after an interruption in the connection with the initial
client station 57 by maintaining an IP address log in
database 65 which records the DNS names of all client

15   stations that have currently been assigned IP addresses
by server 64. Then, when Web server 63 has accessed the
appropriate query response from the Web, server 63 checks
log 65 to confirm that the original IP address is still
assigned to client station, i.e. has not been reassigned.

20   If the IP address has not been reassigned, then the
server 63 goes ahead and routes the query response to the
IP address and, consequently, the query request will
reach client 57 provided there has not been any permanent
interruption of contact with client 57. In any event,

25   the query response will never be delivered
inappropriately should the IP address have been
reassigned.

       Now, with reference to the programming shown in Fig.
3, the program of the present invention is set up

30   primarily in the Service Provider and in the Web server.
A Service Provider is furnished for the distribution of
query requests from any of a set of client stations on
the Web, step 71. The Service Provider's server is

provided with a DHCP protocol for query request
distribution whereby each request is assigned a temporary
IP address for the life of the request, i.e. so long as
the request remains active and uninterrupted, step 72.

5   There is also a provision for the connection of wireless
client stations into the Web so that they may form
wireless stations on the Web and remain part of the
station set supported by the service provider, step 73.
One or more Web servers are provided for access to and

10   from data Web sources and for returning requested query
results to requesting client stations, step 74. A
database log is maintained associated with the service
provider server for storing each temporary IP address of
each client along with the DNS name of the client, step

15   75. There is provided a protocol wherein each Web server
may confirm that the temporary IP address is still
assigned to the DNS client and has not been reassigned
before returning the query response to the requesting
client, step 76.

20   Now, with reference to the flowchart of Fig. 4, a
simplified illustrative run of the process set up in Fig.
3 will be described. Let us assume that we are at a
client station that is about to be activated. An initial
determination is made as to whether the client has

25   requested a query, step 80. If No, the process is
returned to step 80 where a query request by the client
is awaited. If Yes, a query has been requested, then,
step 81, the server of the Service Provider assigns a
temporary IP address in accordance with DHCP protocols

30   and the assignment is recorded in a log in a database
maintained by the Service Provider which correlates the
IP address with the DNS name of the client, step 82. The
requested query is transmitted to a Web server, step 83,

which proceeds in its process of obtaining a query
response from Web resources. During this process, the
system is being monitored for any interruption or
termination of connection, i.e. query, from the

5   requesting client, step 84. If Yes, then the service
provider is advised that the assigned IP address is
available for reassignment, step 85. Irrespective of
whether the client connection has been interrupted/ended,
step 84, the Web server is still accessing the query

10   response, as awaited in step 86. Where the determination
in step 86 is Yes, the access of the query response has
been completed, then the Web server checks the Service
Provider log database to determine if the IP address has
been reassigned, step 87. If Yes, the query is ended

15   without response and the client may be advised
appropriately of an error condition if he is available.
If the decision in step 87 is No, the IP address has not
been reassigned, then the query response is sent to the
requesting client, step 89, and the Service Provider is

20   advised that the IP address is available for
reassignment, step 90.

It should be noted that the programs covered by the
present invention may be stored outside of the present
computer systems until they are required. The program

25   instructions may be stored in another readable medium,
e.g. in disk drive associated with the desktop computer
or in a removable memory such as an optical disk for use
in a CD ROM computer input, or in a floppy disk for use
in a floppy disk drive computer input. Further, the

30   program instructions may be stored in the memory of
another computer prior to use in the system of the
present invention and transmitted over a LAN or a WAN,
such as the Internet, when required by the user of the

present invention. One skilled in the art should
appreciate that the processes controlling the present
invention are capable of being distributed in the form of
computer readable media of a variety of forms.

5   Although certain preferred embodiments have been
shown and described involving the use of DHCP and DNS, it
will be understood that many changes and modifications
may be made therein without departing from the scope and
intent of the appended claims.